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LONG-TERM PLANT SURVIVAL AND DENSITY DATA FROM RECLAIMED SOUTHWESTERN COAL MINE SPOILS

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Abstract.— Plantings on northwestern New Mexico raw mine spoils from 1973, examined for establishment (1975) and survival (1979), showed 75 percent survival of fourwing saltbush (*Atriplex canescens* (Pursh) Nutt.), each plant occupying 2.32 m^2 (1.52 × 1.52 m). Alkali sacaton (*Sporobolus airoides* (Torr.) Torr.) cover was 4 percent and had a density of 0.05 plant per m^2.

When the amount of strip mining of coal increased in the early 1970s in the Four Corners area of New Mexico, the biggest reclamation concern was whether plants could be reestablished at all on these low rainfall sites (Natl. Acad. Sci. 1974). Research and mining company reclamation specialists have shown that plant establishment of native species is both practical and feasible (Aldon 1975a, 1976, 1978). Nevertheless, we still do not know whether these reseeded plants survive and perpetuate themselves into stable ecosystems or how to manage these lands to maintain survival and stability.

This study addresses the survival question. Alkali sacaton and fourwing saltbush plants planted in 1973 on the Navajo Mine near Farmington, New Mexico, were measured in 1975 for establishment and in 1979 for survival. These two species were selected for testing based on previous research of their establishment requirements and their suitability to this site (Aldon 1970, 1975b). This paper presents the first comparisons of long-term survival data for these two species currently used in revegetation of southwestern mine sites.

Descriptions of the sites and planting treatments have been published (Aldon 1975a) and are felt to have little carryover value at this time. Briefly, the plantings were on untreated spoil material (no topsoil used) from the Watson Pit area of the Navajo Mine. The spoil is a dark, shale-derived material having the following characteristics:

Sand, percent	31
Silt, percent	27
Clay, percent	42
Textural class—clay	
Sodium absorption ratio (SAR)	44
Electrical conductivity × 10^3	15
pH	7.7
Na (sol.) (meq/l)	175
Ca + Mg (meq/l)	31
N, kg/ha	146
P_2O_5, kg/ha	46
K_2O, kg/ha	380

The area surrounding the study area is rangeland with a scattering of low-growing shrubs. Principal grasses of the area include galleta (*Hilaria jamesii* (Torr.) Benth.), alkali sacaton, and Indian ricegrass (*Oryzopsis hymenoides* (R. + S.) Ricker). Shadscale (*Atriplex confertifolia* (Torr. + Frem.) Wats.), fourwing saltbush, and broadscale (*Atriplex*

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TABLE 1. Annual precipitation Navajo Mine Watson Pit study site.

Year	Winter December–April (cm)	Growing season May–November (cm)	July–August (cm)	Total (cm)
1974[1]	6.38	8.84	1.14	15.22
1975	6.99	4.98	1.32	11.97
1976	2.29	8.81	5.69	11.10
1977	2.72	6.63	0	9.35
1978	14.15	8.13	0.25	22.28
1979	11.18	7.67	2.08	18.85
			Total	88.77
			Average annual	15.0

[1]Record began September 1973.

obovata Moq.) are the most important shrub species. At higher elevations pinyons (*Pinus edulis* Engelm.) and junipers (*Juniperus* spp.) are found scattered on mesa tops. Elevation ranges from 1524 to 2000 m. Annual precipitation averages only 15 to 20 cm. Summer is usually wetter than winter; spring and fall are the drier seasons (Table 1). Temperatures may reach extremes of –32 to 44 C.

The planting treatments were (A) a direct seeding of fourwing saltbush without irrigation, (B) drip irrigated plantings of three-month-old fourwing saltbush transplants, (C) broadcast seeding of alkali sacaton on roto-tilled plots, and (D) seeding alkali sacaton in furrows. Both types of alkali sacaton seedings were sprinkler irrigated for the first growing season only (Aldon 1975a).

Five years after establishment, 62 percent of the fourwing saltbush plants on the A plots were alive and averaged 72.4 cm in height and 55.4 cm in diameter (Table 2). The plants were 14 percent shorter and 27 percent narrower than they had been five years earlier, probably due to plant competition, because no grazing was present during this time. A live plant now occupies about 2.97 m^2, whereas a mature plant occupied about 1.86 m^2 two years after planting.

Survival of fourwing saltbush on B plots was 88 percent. Average plant height went from 62.2 cm in 1975 to 85.3 cm in 1979 and average plant diameter went from 59.7 cm to 98.3 cm (Table 2). Each live plant now occupies about 2.23 m^2.

Combining data from plots A and B, a fourwing saltbush plant occupies on the average 2.3 m^2 or an area 1.52 m × 1.52 m. Plant size and spacing seem to be related. Closely spaced plants were smaller and had large die-offs when compared with plants that were more widely spaced initially.

In 1979, on the C plots, there was an average of 36.8 surviving alkali sacaton plants. Average diameter was 10.16 cm. For mature plants the cover is 5.3 percent and density is 0.06 plants/m^2 (Table 3).

The D plots showed an average of 2.6 percent cover value. Using a plant count on the furrow plots, with a 10.16 cm average

TABLE 2. Survival and growth of fourwing saltbush.

Treatments	Live plants A	Live plants B	Spacing A (m^2/plant)	Spacing B (m^2/plant)	Average Height A (cm)	Average Height B (cm)	Average Diameter A (cm)	Average Diameter B (cm)
Measurement dates		#						
May 1973	400	—*	0.28	—		Seedlings		
September 1973	200	70	0.56	1.39		Seedlings		
July 1975	—	51	—	1.95	—	62.2	—	59.7
September 1975	60	—	1.86	—	82.3	—	75.7	—
May 1979	37	45	2.97	2.23	72.4	85.3	55.4	98.3
Percent survival (75–79)	61.7	88.2						

*— = measurement not taken

measured plant diameter, plant density was 0.04 plants/m².

Combining plots C and D, alkali sacaton averages 4 percent cover, 0.05 live mature plants per m² density.

These alkali sacaton densities are comparable to the 5.3 percent cover and 0.04 plants per m² found in three unmined semiarid pastures measured in another study, on the Rio Puerco watershed, near San Isidro, New Mexico, after two years of above average precipitation. The area, about 120 miles southeast of the present study site, normally receives about 24.1 cm of annual precipitation.

The potential for these two plants to reseed themselves on these sites is not fully understood. Moreover, complete understanding of mine spoil reclamation will have to be based on studies involving entire ecosystems over much longer periods of time. Nevertheless, these data give us some clues as to what plant densities can be established and sustained in this environment. Survival of these two species under difficult climatic and spoils conditions represents a significant start in the reclamation process on semiarid southwestern mined areas.

Table 3. Alkali sacaton plant density and cover.

Treatment	Density 1975 (seedlings/m²)	Density 1979 (plants/m²)	Cover 1979 (%)
C	0.36	0.06	5.3
D	0.29	0.04	2.6

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Literature Cited

ALDON, E. F. 1970. Fourwing saltbush can be field planted successfully. U.S. Forest Service Research Note RM-173, 2 pp.

———. 1975a. Techniques for establishing native plants on coal mine spoils in New Mexico. Pages 21–28 *in* third symposium on surface mining and reclamation, Vol. 1. NCA/BCR Coal Conf. and Expo II. Louisville, Kentucky, Natl. Coal Assoc., Washington, D.C. 243 pp.

———. 1975b. Establishing alkali sacaton on harsh sites in the Southwest. J. of Range Manage. 28(2):129–132.

———. 1978. Reclamation of coal-mined land in the Southwest. J. Soil and Water Con. March–April 33(2):75–79.

ALDON, E. F., H. W. SPRINGFIELD, AND W. SOWARDS. 1976. Demonstration test of two irrigation systems for plant establishment on coal mine spoils. Pages 201–214 *in* fourth symposium on surface mining and reclamation. NCA/BCR Coal Conf. and Expo III. Louisville, Kentucky, Natl. Coal Assoc., Washington, D.C. 276 pp.

NATIONAL ACADEMY OF SCIENCE ENVIRONMENTAL STUDIES BOARD. 1974. Study committee on the potential for rehabilitating land surface mined for coal in the western United States. Ballinger, Cambridge, Massachusetts, 198 pp.